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PATENT ABSTRACTS OF JAPAN

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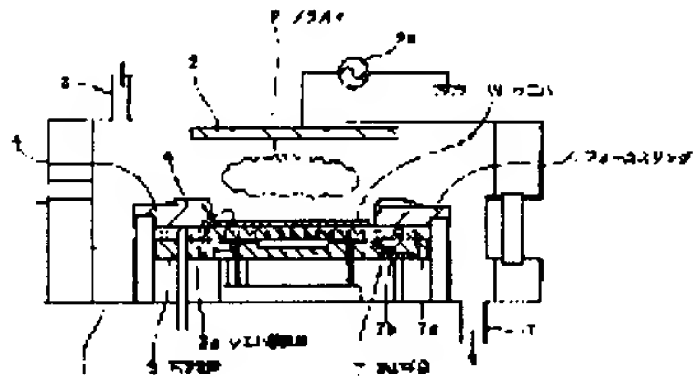
(54) ETCHING APPARATUS AND METHOD THEREOF

(57)Abstract:

PROBLEM TO BE SOLVED: To prevent sediment on the surface of focus ring from peeling off during etching and to allaining the form accuracy of etching from being unattarnable.

SOLUTION: An etching device, where the wafer loading face 3a of a lower electrode 3 is formed at a base and a focus ring 4 is installed at a periphery side of the lower electrode 3, is provided with a cooling means 7 at the base of the focus ring 4. In a cooling means 7, a refrigerant pipe 7b, circulating a refrigerant along the base of the focus ring 4, is installed in a base material 7a which is closely arranged along the base of the focus ring 4. Thus, etching can be realized while the surface of the focus ring 4 is cooled. Thus, a sediment (a) is prevented from peeling off from the surface of the focus ring 4 due to the heating of the surface of the focus ring 4.



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* NOTICES *

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MEANS

[The means for solving a technical problem] The etching system of this invention for solving the above-mentioned technical probrem uses the wafer installation side of a lower electrode as a base, and is characterized by preparing a cooling means to cool the front face of the concerned focal ring in the aforementioned focal ring in the etching system which comes to prepare a focal ring in the side periphery of the concerned lower electrode.
[0010] According to the above-mentioned etching system, the front face of a focal ring is cooled by the cooling means prepared in the focal ring. For this reason, even if generation of heat arises around a focal ring in the case of etching, where the front face of a focal ring is cooled, etching of the wafer laid on the lower electrode is performed. Therefore, the sediment of the resultant [front face / of a focal ring] in the case of etching comes to seldom exfoliate from the concerned focal ring.
[0011] Moreover, the etching technique of this invention is characterized by cooling the front face of the aforementioned focal ring in the technique of etching the front face of the concerned wafer, when a side periphery supplies a plasma to the front face of the wafer surrounded in the focal ring.
[0012] According to the above-mentioned etching technique, etching is performed where the front face of a focal ring is cooled. For this reason, the sediment of a resultant in the front face of a focal ring comes to seldom exfoliate from the concerned focal ring in the case of etching. Therefore, etching is performed, without dropping the sediment of a focal ring front face on a wafer.
[0013]
[Gestalt of implementation of invention] Hereafter, the gestalt of the enforcement which applied the etching system and the etching technique of this invention is explained based on a drawing. Drawing 1 is is the important section block diagram showing the 1 enforcement gestalt of the etching system of this invention, and explains the gestalt of enforcement of an etching system first using this drawing. In addition, it is explained that the Prior art explained to the same component by attaching the same sign.
[0014] The etching system shown in this drawing is an parallel monotonous type etching system, and is also having a reaction chamber 1, the up electrode 2 and the lower electrode 3 prepared in the status countering mutually in this reaction chamber 1, and the focal ring 4 prepared in the side periphery of the lower electrode 3.
[0015] The gas introduction spool 6 for introducing process gas in the concerned reaction chamber 1 is connected to the top of a reaction chamber 1. Moreover, the exhaust pipe 7 for exhausting the gas in a reaction chamber 1 is connected to the inferior surface of tongue of a reaction chamber 1. And it connects with the load lock chamber which omitted illustration here, and wafer W contains a reaction chamber 1, securing a vacua from this load lock chamber in a reaction chamber 1. Moreover, the ********** room which makes two or more other reaction chambers and wafers stand by besides this reaction chamber 1 may be connected to the above-mentioned load lock chamber, and it may be collectively constituted as a multi chamber.
[0016] And the above-mentioned up electrode 2 is formed in the upper part of a reaction chamber 1, and is connected to RF-generator 2a used as the source of plasma excitation. Furthermore, the above-mentioned lower electrode 3 is constituted as a **** chuck by which it is prepared in the reaction

in reaction chamber 1 facing electrode 2
Electrostatic chuck cooler supply passage built in

chamber 1 in the status counter with the up electrode 2, for example, the refrigerant introduction way was inner-**ed. s provided

[0017] Moreover, the above-mentioned focal ring 4 is in the status which uses wafer installation 3a in the lower electrode 3 as a base, and constitutes the side peripheral wall, and is prepared in the upper part side periphery of the concerned lower electrode 3. And the cooling means 7 which is a component characteristic of this invention is formed in the base of this focal ring 4 of this. About refrigerant spool 7b which circulates a refrigerant along the base of the focal ring 4 in base-material 7a which consists of a thermally conductive good material which was prepared along the inferior surface of tongue of the focal ring 4, is stuck on the inferior surface of tongue of the focal ring 4, and was prepared, inner, it **s and this cooling means 7 becomes. This refrigerant spool 7b is prepared individually [the refrigerant introduction way of the lower electrode 3]. Moreover, the cooling means 7 is equipped with the temperature-control function (illustration ellipsis) for controlling the skin temperature of the focal ring 4, and suppose that it is constituted independently possible [a control] to the skin temperature of the focal ring 4 independently [the up electrode 2, the lower electrode 3, the reaction chamber 1, etc.].

[0018] By the etching system of the above-mentioned configuration, the plasma of process gas occurs in a reaction chamber 1 by changing the inside of a reaction chamber 1 into the predetermined reduced pressure status, introducing process gas from the gas introduction spool 6, and impressing a RF to the up electrode 2 from RF-generator 2a by the exhaust air from an exhaust pipe 7. In this case, with the focal ring 4 prepared in the side periphery of the lower electrode 3, a plasma is equally supplied to wafer W laid on the lower electrode 3, and it is etched by this plasma in the front face of wafer W. And since the front face of the focal ring 4 is cooled by the cooling means 7 especially prepared in the inferior surface of tongue of the focal ring 4, in case it is etching, it is suppressed by the direct heat received from plasma P, and the radiant heat from the up electrode 2 and reaction chamber 1 side attachment wall by it, that the skin temperature of the focal ring 4 rises. For this reason, even if the resultant by etching accumulates on focal ring 4 front face and sediment a is formed, this sediment a comes to seldom separate from focal ring 4 front face. Therefore, this sediment a does not fall on wafer W in the case of etching.

[0019] Drawing 2 is cross-section process drawing for explaining the gestalt of the enforcement which applied the etching technique of this invention to the formation technique of the plug which consists of a tungsten. Above-mentioned drawing 1 is used for below with this drawing 2 , and the formation technique of the plug which consists of a tungsten using the above-mentioned etching system is explained.

[0020] First, as shown in drawing 2 (1), the lower layer wiring 22 which becomes the upper part of a substrate 21 from contest polysilicon is formed. Formation of this lower layer wiring 22 is performed by carrying out patterning of the polysilicon contest layer formed by the CVD (Chemical Vapor Depositin) method. Next, the layer insulation layer 11 is formed for the lower layer wiring 22 on a substrate 21 in the state of a wrap. Suppose that it consists of BPSG layer or PSG layer formed by CVD to this layer insulation layer 11. Then, the through hole 12 which reaches the lower layer wiring 22 is formed in this layer insulation layer 11 by carrying out patterning of the layer insulation layer 11.

[0021] Subsequently, as shown in drawing 2 (2), the adhesion layer 13 which consists the wall of a through hole 12 of titanium on the layer insulation layer 11 in the state of a wrap is formed in a spatter. Then, the tungsten layer (it is hereafter described as a tungsten layer) 14 is formed on the adhesion layer 13 by the thickness exceeding the depth of a through hole 12. By this, the inside of a through hole 12 is completely embedded by the tungsten layer 14.

[0022] As shown in drawing 2 (3) after more than, etchback of the tungsten layer 14 and the adhesion layer 13 is carried out from the front-face side, and the tungsten layer 14 and the adhesion layer 13 on the layer insulation layer 11 are removed so that it may leave the tungsten layer 14 and the adhesion layer 13 only to the interior of a through hole 12.

[0023] In this case, after laying a substrate 21 (namely, wafer W) on installation side 3a of the lower electrode 3 and decompressing the inside of a reaction chamber 1 even to a predetermined pressure by the exhaust air from an exhaust pipe 7 using the etching system explained using above-mentioned

drawing 1 , where process gas is introduced by the predetermined flow rate from the gas introduction spool 6, high-frequency voltage is impressed to the up electrode 2 from RF-generator 2a. By this, plasma P of process gas is generated in a reaction chamber 1, this plasma P is supplied to the front face of wafer W surrounded in the focal ring 4, and wafer W is etched from the front-face side by this.
[0024] In this case, it becomes the characteristic feature of this enforcement gestalt to cool the front face of the focal ring 4 by making refrigerant spool 7b in the cooling means 7 of an etching system circulate through a refrigerant especially. As cooling conditions of the focal ring 4, it considers as desirable temperature lower than the skin temperature of wafer W. As an example of cooling conditions, when it controls at temperature =70 degree C of the up electrode 2, temperature =25 degree C of the lower electrode 3, and temperature =45 degree C of reaction chamber 1 side attachment wall, it is set as about [of the focal ring 4 / cooling temperature =20 degree C].
[0025] An example of the tungsten layer 14 under the above-mentioned temperature condition and the etching conditions of the adhesion layer 13 is shown below.
- Initial etching conditions of the tungsten layer 14 (the 1st step), Process gas and flow rate ; 6 fluoride [sulfur] (SF6) =110sccm, Argon (Ar) = 90sccm, Etching ambient-atmosphere internal pressure ; 37.3Pa, RF (13.56MHz) impression power;600W, Etching time ; 35 seconds.
- Up to the etching conditions (the 2nd step) of the tungsten layer 14, and terminal-point detection. Process gas and flow rate ; 6 fluoride [sulfur] (SF6) = 80sccm, Argon (Ar) = 40sccm, Etching ambient-atmosphere internal pressure ; 28.0Pa, RF (13.56MHz) impression power;300W, Etching time ;
- Over etching conditions of the tungsten layer 14 (the 3rd step), Process gas and flow rate ; 6 fluoride [sulfur] (SF6) = 80sccm, Argon (Ar) = 40sccm, Etching ambient-atmosphere internal pressure ; 28.0Pa, RF (13.56MHz) impression power;300W, Etching time ; 45 seconds.
- Etching conditions of the adhesion layer 13, Process gas and flow rate ; Chlorine (Cl2) = 20sccm, Nitrogen (N2) =200sccm, Etching ambient-atmosphere internal pressure ; 5.3Pa, RF (13.56MHz) impression power;550W, Etching time ; 75 seconds.
however, the above-mentioned sccm -- standard cubic centimeter/minutes it is -- it considers as things
[0026] Plug 14a which consists of a tungsten through the adhesion layer 13 is formed in this through hole 12 by leaving the adhesion layer 13 and the tungsten layer 14 only in a through hole 12 as mentioned above.
[0027] Then, as shown in drawing 3 , the aluminum layer 15 is formed for plug 14a in the state of a wrap on the layer insulation layer 11 by the spatter, patterning of this aluminum layer 15 is carried out, and upper wiring 15a which consists of aluminum is formed. The semiconductor device which comes to form upper wiring 15a connected to plug 14a by this on the layer insulation layer 11 is completed.
[0028] By the above-mentioned technique, where the front face of the focal ring 4 is cooled, etchback of the tungsten layer 14 is performed, and in case it is this etchback, it is suppressed by the direct heat received from plasma P, and the radiant heat from the up electrode 2 and reaction chamber 1 side attachment wall that the skin temperature of the focal ring 4 rises. For this reason, it becomes possible to make to exfoliate sediment a of the resultant in the front face of the focal ring 4 from the concerned focal ring 4. Therefore, in the case of the above-mentioned etchback, on wafer W, sediment a separates and does not fall, and this sediment a remains on the layer insulation layer 11, or producing the etching remainder which used this sediment a as the mask is prevented. Consequently, it enables it to prevent that between upper wiring 15a formed on the layer insulation layer 11 short-circuits by sediment a or the above-mentioned etching remainder, and to aim at enhancement in the yield of a semiconductor device.
[0029] In the above-mentioned enforcement gestalt, the etching system of a configuration of having formed the cooling means 7 in the inferior surface of tongue of the focal ring 4 was illustrated. However, as a cooling means 7, you may be the configuration of having inner-**ed the refrigerant spool to the focal ring 4. moreover, the thing of the parallel monotonous type explained with this enforcement gestalt when it was the etching system 4 which the etching system of this invention uses wafer installation side 3a of the lower electrode 3 as a base, and has the focal ring 4 in the side periphery -- limited **** -- things can be applied to the etching system of the others which there are not, for example, make a magnetron, efficient consumer response, inductive discharge, or a helicon wave the source of a plasma,

and can acquire the same effect

[0030] Moreover, in the above-mentioned enforcement gestalt, the etching technique at the time of using the above-mentioned etching system for the etchback of the tungsten layer in formation of a tungsten plug was explained. However, the etching technique of this invention is not limited to this, and the thing in patterning for wiring formation or through hole formation etc. for which it is applied also to etching in addition to this, and the same effect is acquired is possible for it.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[An easy explanation of a drawing]
[Drawing 1] It is the important section block diagram showing the 1 enforcement gestalt of the etching system of this invention.
[Drawing 2] It is cross-section process drawing for explaining the enforcement gestalt which applied the etching technique of this invention to the formation technique of the plug which consists of a tungsten.
[Drawing 3] It is the cross section of the semiconductor device formed with the application of the etching technique of this invention.
[Drawing 4] It is the important section block diagram showing an example of the conventional etching system.
[Drawing 5] It is a cross section for explaining the conventional technical probrem.
[An explanation of a sign]
3 [-- A focal ring, 7 / -- A cooling means, P / -- A plasma, W / -- Wafer] -- A lower electrode, 3a -- A wafer installation side, 4

[Translation done.]

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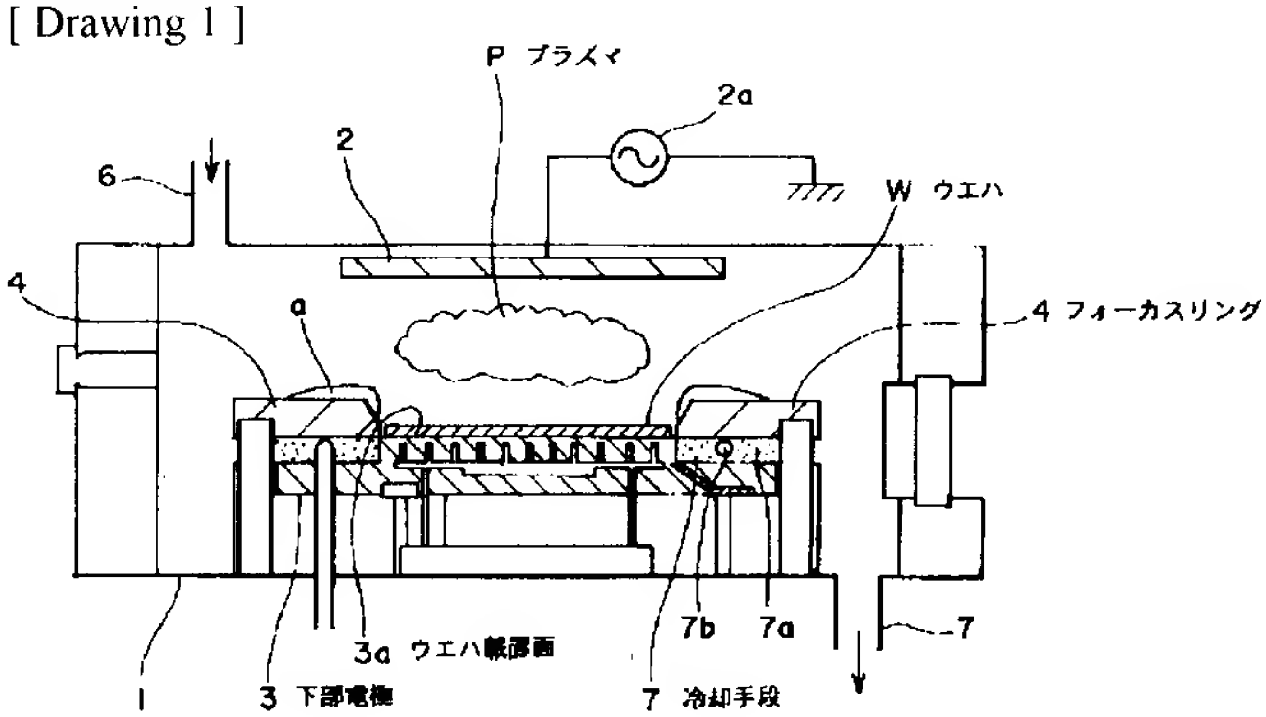
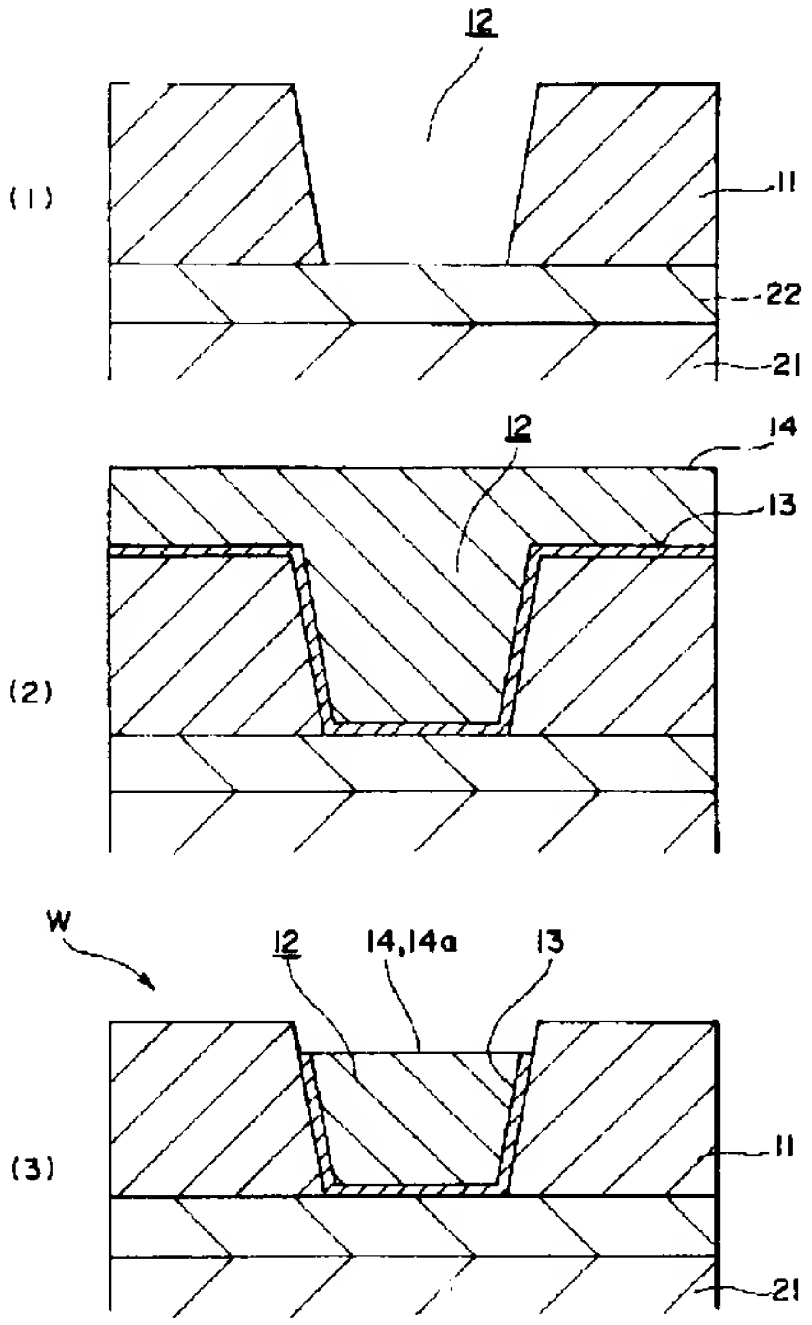
DRAWINGS

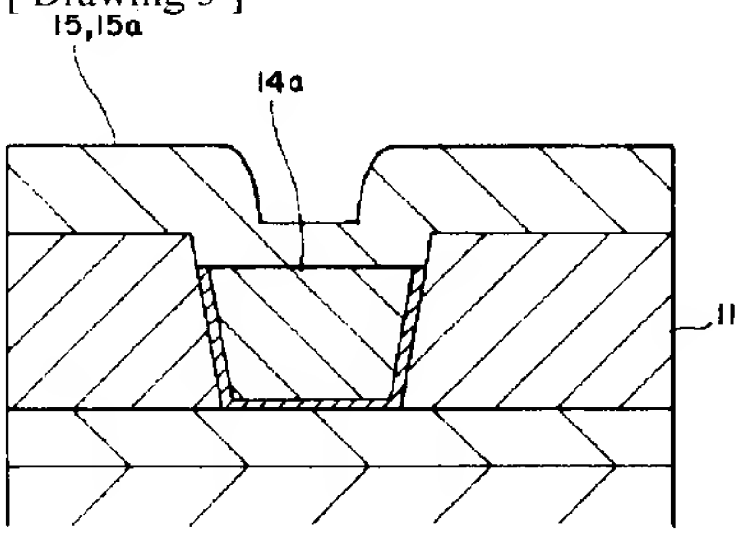
[Drawing 1]



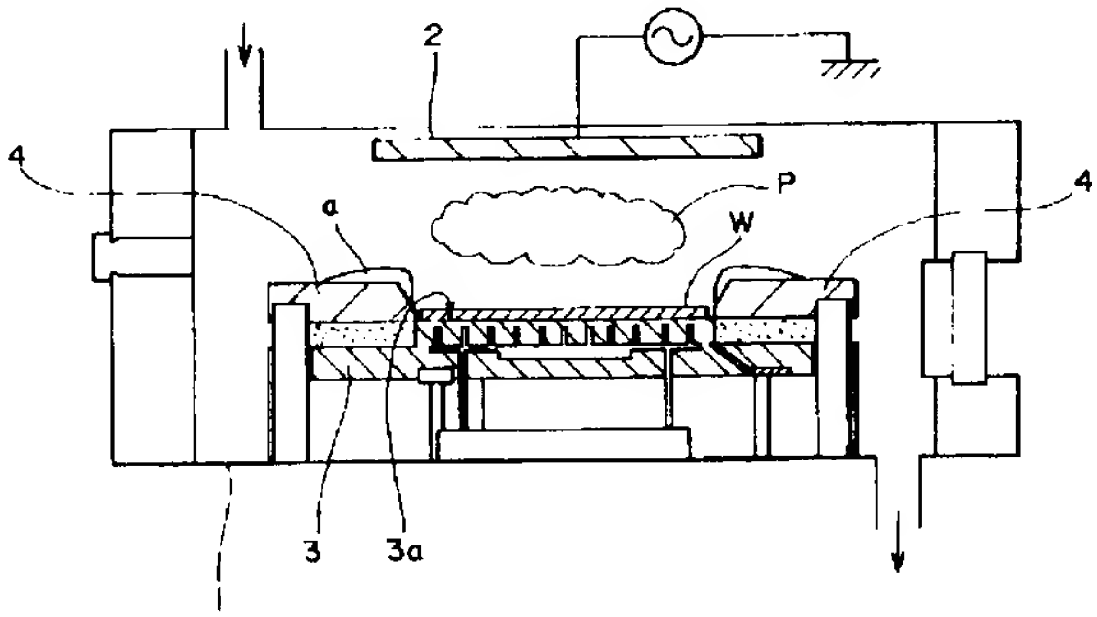
[Drawing 2]



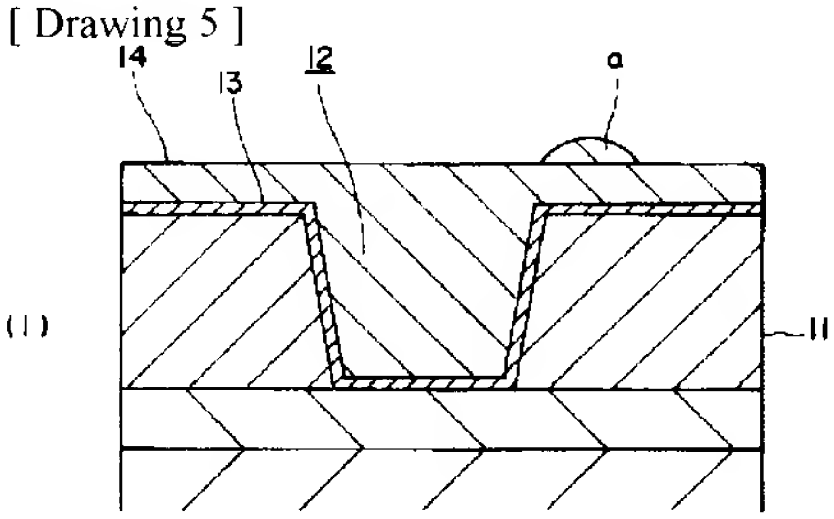
[Drawing 3]

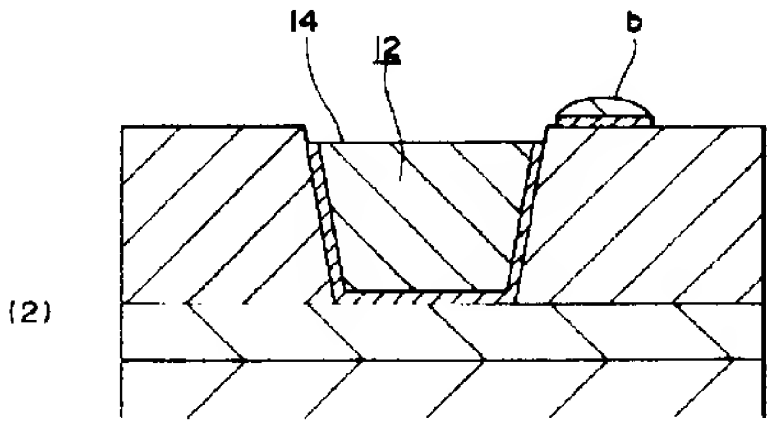


[Drawing 4]



[Drawing 5]





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DETAILED DESCRIPTION

[Detailed description]
[0001]
[The technical field to which invention belongs] this invention relates to the etching system which comes to prepare a focal ring in the side periphery of the lower electrode which lays especially a ** wafer, and the etching technique using this etching system about the etching system and the etching technique which are used in the manufacturing process of a semiconductor device.
[0002]
[Prior art] The important section block diagram of the etching system used by the manufacturing process of a semiconductor device was shown in drawing 4 . The etching system shown in this drawing is also having a reaction chamber 1, the up electrode 2 and the lower electrode 3 prepared in the status countering mutually, in this reaction chamber 1, and the focal ring 4 which uses wafer installation side 3a in the lower electrode 3 as a base, and was prepared in the side periphery.
[0003] In etching the front face of a wafer using this etching system, first, wafer W is laid on wafer installation side 3a of the lower electrode 3, and it surrounds the side periphery of wafer W in a focal ring. Then, where process gas is introduced in a reaction chamber 1, a RF is impressed to the up electrode 2, by this, plasma P of process gas is generated in a reaction chamber 1, and plasma P is supplied to a wafer W front face. And the front face of the concerned wafer W is etched by this plasma P. In this case, plasma P is equally supplied to the wafer W front face laid on the lower electrode 3 by the focal ring 4 being formed in the status surround the side periphery of wafer W, and the homogeneity within a wafer side in etching is acquired.
[0004]
[Object of the Invention] However, the following technical probrems occur in the above-mentioned etching system and etching using this. That is, as shown in drawing 4 , since the focal ring was prepared in the side periphery of the lower electrode 3, the resultant by etching adheres to the front face of this focal ring 4, and sediment a by the above-mentioned resultant comes to be constituted from an etching system of the above-mentioned configuration by the front face of the focal ring 4 by piling up the processing number of sheets of wafer W. However, in the case of etching, the skin temperature of the focal ring 4 rises by the direct heat received from plasma P, and the radiant heat from the up electrode 2 and reaction chamber 1 side attachment wall. For this reason, the above-mentioned sediment a becomes easy to separate from the front face of the focal ring 4, and sediment a may fall on the front face of wafer W in the middle of etching. In such a case, this sediment a becomes the mask of etching and the etching remainder arises on the front face of wafer W.
[0005] progress of the micro-processing technique accompanied by a demand of high integration of recent years and a semiconductor device and highly-efficient-izing -- detailed-izing of the path of through holes, such as a dimension of a wiring, and a contact hole, -- progressing -- the inside of the above-mentioned through hole -- a tungsten -- like -- more -- low -- the plug using the conductive material [****] has come to form And after forming the tungsten layer 14 through the adhesion layer 13 first in the status embed the inside of the through hole 12 formed in the layer insulation layer 11 as

shown in drawing 5 (1) in forming this plug using the above-mentioned etching system, etchback of the adhesion layer 13 and the tungsten layer 14 is carried out using the above-mentioned etching system. And as shown in drawing 5 (2), only in a through hole 12, it leaves the tungsten layer 14 and this is formed as plug 14a.

[0006] However, this sediment becomes the mask of etching when sediment a separated and falls to the front face of wafer W in the middle of the etchback of the tungsten layer which was with the above-mentioned etching system as mentioned above. Consequently, the etching remaining b of a tungsten layer arises on the layer insulation layer 11 after an etchback end. And when the upper wiring (illustration ellipsis) is formed on the layer insulation layer 11 at a next process, the etching remaining b will remain between this upper wiring. This etching remaining b makes between the upper wirings short-circuit, and becomes the factor which reduces the yield of a semiconductor device. This is the same even when the sediment a itself remains on the layer insulation layer 11, and it becomes the factor in which this sediment a makes between the above-mentioned upper wirings short-circuit.

[0007] Moreover, even if it was except formation of the above-mentioned plug, when the above-mentioned sediment a drops out on a wafer in etching at the time of carrying out patterning of the wiring, for example, this sediment a becomes the factor which makes between wirings short-circuit.

[0008] Then, this invention aims at offering the etching system and the etching technique of preventing that the sediment of the resultant by etching separates in the shape of a wafer, and falls from a focal ring.

[0009]

[The means for solving a technical problem] The etching system of this invention for solving the above-mentioned technical probrem uses the wafer installation side of a lower electrode as a base, and is characterized by preparing a cooling means to cool the front face of the concerned focal ring in the aforementioned focal ring in the etching system which comes to prepare a focal ring in the side periphery of the concerned lower electrode.

[0010] According to the above-mentioned etching system, the front face of a focal ring is cooled by the cooling means prepared in the focal ring. For this reason, even if generation of heat arises around a focal ring in the case of etching, where the front face of a focal ring is cooled, etching of the wafer laid on the lower electrode is performed. Therefore, the sediment of the resultant [front face / of a focal ring] in the case of etching comes to seldom exfoliate from the concerned focal ring.

[0011] Moreover, the etching technique of this invention is characterized by cooling the front face of the aforementioned focal ring in the technique of etching the front face of the concerned wafer, when a side periphery supplies a plasma to the front face of the wafer surrounded in the focal ring.

[0012] According to the above-mentioned etching technique, etching is performed where the front face of a focal ring is cooled. For this reason, the sediment of a resultant in the front face of a focal ring comes to seldom exfoliate from the concerned focal ring in the case of etching. Therefore, etching is performed, without dropping the sediment of a focal ring front face on a wafer.

[0013]

[Gestalt of implementation of invention] Hereafter, the gestalt of the enforcement which applied the etching system and the etching technique of this invention is explained based on a drawing. Drawing 1 is is the important section block diagram showing the 1 enforcement gestalt of the etching system of this invention, and explains the gestalt of enforcement of an etching system first using this drawing. In addition, it is explained that the Prior art explained to the same component by attaching the same sign.

[0014] The etching system shown in this drawing is an parallel monotonous type etching system, and is also having a reaction chamber 1, the up electrode 2 and the lower electrode 3 prepared in the status countering mutually in this reaction chamber 1, and the focal ring 4 prepared in the side periphery of the lower electrode 3.

[0015] The gas introduction spool 6 for introducing process gas in the concerned reaction chamber 1 is connected to the top of a reaction chamber 1. Moreover, the exhaust pipe 7 for exhausting the gas in a reaction chamber 1 is connected to the inferior surface of tongue of a reaction chamber 1. And it connects with the load lock chamber which omitted illustration here, and wafer W contains a reaction

chamber 1, securing a vacua from this load lock chamber in a reaction chamber 1. Moreover, the ********** room which makes two or more other reaction chambers and wafers stand by besides this reaction chamber 1 may be connected to the above-mentioned load lock chamber, and it may be collectively constituted as a multi chamber.

[0016] And the above-mentioned up electrode 2 is formed in the upper part of a reaction chamber 1, and is connected to RF-generator 2a used as the source of plasma excitation. Furthermore, the above-mentioned lower electrode 3 is constituted as a **** chuck by which it is prepared in the reaction chamber 1 in the status counter with the up electrode 2, for example, the refrigerant introduction way was inner-**ed.

[0017] Moreover, the above-mentioned focal ring 4 is in the status which uses wafer installation 3a in the lower electrode 3 as a base, and constitutes the side peripheral wall, and is prepared in the upper part side periphery of the concerned lower electrode 3. And the cooling means 7 which is a component characteristic of this invention is formed in the base of this focal ring 4 of this. About refrigerant spool 7b which circulates a refrigerant along the base of the focal ring 4 in base-material 7a which consists of a thermally conductive good material which was prepared along the inferior surface of tongue of the focal ring 4, is stuck on the inferior surface of tongue of the focal ring 4, and was prepared, inner, it **s and this cooling means 7 becomes. This refrigerant spool 7b is prepared individually [the refrigerant introduction way of the lower electrode 3]. Moreover, the cooling means 7 is equipped with the temperature-control function (illustration ellipsis) for controlling the skin temperature of the focal ring 4, and suppose that it is constituted independently possible [a control] to the skin temperature of the focal ring 4 independently [the up electrode 2, the lower electrode 3, the reaction chamber 1, etc.].

[0018] By the etching system of the above-mentioned configuration, the plasma of process gas occurs in a reaction chamber 1 by changing the inside of a reaction chamber 1 into the predetermined reduced pressure status, introducing process gas from the gas introduction spool 6, and impressing a RF to the up electrode 2 from RF-generator 2a by the exhaust air from an exhaust pipe 7. In this case, with the focal ring 4 prepared in the side periphery of the lower electrode 3, a plasma is equally supplied to wafer W laid on the lower electrode 3, and it is etched by this plasma in the front face of wafer W. And since the front face of the focal ring 4 is cooled by the cooling means 7 especially prepared in the inferior surface of tongue of the focal ring 4, in case it is etching, it is suppressed by the direct heat received from plasma P, and the radiant heat from the up electrode 2 and reaction chamber 1 side attachment wall by it, that the skin temperature of the focal ring 4 rises. For this reason, even if the resultant by etching accumulates on focal ring 4 front face and sediment a is formed, this sediment a comes to seldom separate from focal ring 4 front face. Therefore, this sediment a does not fall on wafer W in the case of etching.

[0019] Drawing 2 is cross-section process drawing for explaining the gestalt of the enforcement which applied the etching technique of this invention to the formation technique of the plug which consists of a tungsten. Above-mentioned drawing 1 is used for below with this drawing 2 , and the formation technique of the plug which consists of a tungsten using the above-mentioned etching system is explained.

[0020] First, as shown in drawing 2 (1), the lower layer wiring 22 which becomes the upper part of a substrate 21 from contest polysilicon is formed. Formation of this lower layer wiring 22 is performed by carrying out patterning of the polysilicon contest layer formed by the CVD (Chemical Vapor Depositin) method. Next, the layer insulation layer 11 is formed for the lower layer wiring 22 on a substrate 21 in the state of a wrap. Suppose that it consists of BPSG layer or PSG layer formed by CVD to this layer insulation layer 11. Then, the through hole 12 which reaches the lower layer wiring 22 is formed in this layer insulation layer 11 by carrying out patterning of the layer insulation layer 11.

[0021] Subsequently, as shown in drawing 2 (2), the adhesion layer 13 which consists the wall of a through hole 12 of titanium on the layer insulation layer 11 in the state of a wrap is formed in a spatter. Then, the tungsten layer (it is hereafter described as a tungsten layer) 14 is formed on the adhesion layer 13 by the thickness exceeding the depth of a through hole 12. By this, the inside of a through hole 12 is completely embedded by the tungsten layer 14.

[0022] As shown in drawing 2 (3) after more than, etchback of the tungsten layer 14 and the adhesion layer 13 is carried out from the front-face side, and the tungsten layer 14 and the adhesion layer 13 on the layer insulation layer 11 are removed so that it may leave the tungsten layer 14 and the adhesion layer 13 only to the interior of a through hole 12.
[0023] In this case, after laying a substrate 21 (namely, wafer W) on installation side 3a of the lower electrode 3 and decompressing the inside of a reaction chamber 1 even to a predetermined pressure by the exhaust air from an exhaust pipe 7 using the etching system explained using above-mentioned drawing 1 , where process gas is introduced by the predetermined flow rate from the gas introduction spool 6, high-frequency voltage is impressed to the up electrode 2 from RF-generator 2a. By this, plasma P of process gas is generated in a reaction chamber 1, this plasma P is supplied to the front face of wafer W surrounded in the focal ring 4, and wafer W is etched from the front-face side by this.
[0024] In this case, it becomes the characteristic feature of this enforcement gestalt to cool the front face of the focal ring 4 by making refrigerant spool 7b in the cooling means 7 of an etching system circulate through a refrigerant especially. As cooling conditions of the focal ring 4, it considers as desirable temperature lower than the skin temperature of wafer W. As an example of cooling conditions, when it controls at temperature =70 degree C of the up electrode 2, temperature =25 degree C of the lower electrode 3, and temperature =45 degree C of reaction chamber 1 side attachment wall, it is set as about [of the focal ring 4 / cooling temperature =20 degree C].
[0025] An example of the tungsten layer 14 under the above-mentioned temperature condition and the etching conditions of the adhesion layer 13 is shown below.
- Initial etching conditions of the tungsten layer 14 (the 1st step), Process gas and flow rate ; 6 fluoride [sulfur] (SF6) =110sccm, Argon (Ar) = 90sccm, Etching ambient-atmosphere internal pressure ; 37.3Pa, RF (13.56MHz) impression power;600W, Etching time ; 35 seconds.
- Up to the etching conditions (the 2nd step) of the tungsten layer 14, and terminal-point detection. Process gas and flow rate ; 6 fluoride [sulfur] (SF6) = 80sccm, Argon (Ar) = 40sccm, Etching ambient-atmosphere internal pressure ; 28.0Pa, RF (13.56MHz) impression power;300W, Etching time ;
- Over etching conditions of the tungsten layer 14 (the 3rd step), Process gas and flow rate ; 6 fluoride [sulfur] (SF6) = 80sccm, Argon (Ar) = 40sccm, Etching ambient-atmosphere internal pressure ; 28.0Pa, RF (13.56MHz) impression power;300W, Etching time ; 45 seconds.
- Etching conditions of the adhesion layer 13, Process gas and flow rate ; Chlorine (Cl2) = 20sccm, Nitrogen (N2) =200sccm, Etching ambient-atmosphere internal pressure ; 5.3Pa, RF (13.56MHz) impression power;550W, Etching time ; 75 seconds.
however, the above-mentioned sccm -- standard cubic centimeter/minutes it is -- it considers as things
[0026] Plug 14a which consists of a tungsten through the adhesion layer 13 is formed in this through hole 12 by leaving the adhesion layer 13 and the tungsten layer 14 only in a through hole 12 as mentioned above.
[0027] Then, as shown in drawing 3 , the aluminum layer 15 is formed for plug 14a in the state of a wrap on the layer insulation layer 11 by the spatter, patterning of this aluminum layer 15 is carried out, and upper wiring 15a which consists of aluminum is formed. The semiconductor device which comes to form upper wiring 15a connected to plug 14a by this on the layer insulation layer 11 is completed.
[0028] By the above-mentioned technique, where the front face of the focal ring 4 is cooled, etchback of the tungsten layer 14 is performed, and in case it is this etchback, it is suppressed by the direct heat received from plasma P, and the radiant heat from the up electrode 2 and reaction chamber 1 side attachment wall that the skin temperature of the focal ring 4 rises. For this reason, it becomes possible to make to exfoliate sediment a of the resultant in the front face of the focal ring 4 from the concerned focal ring 4. Therefore, in the case of the above-mentioned etchback, on wafer W, sediment a separates and does not fall, and this sediment a remains on the layer insulation layer 11, or producing the etching remainder which used this sediment a as the mask is prevented. Consequently, it enables it to prevent that between upper wiring 15a formed on the layer insulation layer 11 short-circuits by sediment a or the above-mentioned etching remainder, and to aim at enhancement in the yield of a semiconductor device.
[0029] In the above-mentioned enforcement gestalt, the etching system of a configuration of having

formed the cooling means 7 in the inferior surface of tongue of the focal ring 4 was illustrated. However, as a cooling means 7, you may be the configuration of having inner-**ed the refrigerant spool to the focal ring 4. moreover, the thing of the parallel monotonous type explained with this enforcement gestalt when it was the etching system 4 which the etching system of this invention uses wafer installation side 3a of the lower electrode 3 as a base, and has the focal ring 4 in the side periphery -- limited **** -- things can be applied to the etching system of the others which there are not, for example, make a magnetron, efficient consumer response, inductive discharge, or a helicon wave the source of a plasma, and can acquire the same effect

[0030] Moreover, in the above-mentioned enforcement gestalt, the etching technique at the time of using the above-mentioned etching system for the etchback of the tungsten layer in formation of a tungsten plug was explained. However, the etching technique of this invention is not limited to this, and the thing in patterning for wiring formation or through hole formation etc. for which it is applied also to etching in addition to this, and the same effect is acquired is possible for it.

[0031]

[Effect of the invention] Since etching of the wafer laid on the lower electrode where the front face of a focal ring is cooled can be performed according to the etching system of this invention as explained above, in case it is etching, it can prevent that a focal ring is heated, and a surface sediment separates and falls on a wafer. Therefore, it enables the precision of a configuration to perform good etching. Moreover, according to the etching technique of this invention, it is enabled to perform etching, without making the sediment of a resultant in the front face of a focal ring exfoliate from the concerned focal ring by performing etching, cooling the front face of a focal ring. Therefore, fall of the sediment to a wafer top can be prevented and it is enabled to perform etching with a good precision of a configuration.

[Translation done.]

* NOTICES *

CLAIMS

[Claim]
[Claim 1] The etching system which uses the wafer installation side of a lower electrode as a base, and is characterized by preparing a cooling means to cool the front face of the concerned focal ring in the aforementioned focal ring in the etching system which comes to prepare a focal ring in the side periphery of the concerned lower electrode.
[Claim 2] The etching technique characterized by cooling the front face of the aforementioned focal ring in the technique of etching the front face of the concerned wafer when a side periphery supplies a plasma to the front face of the wafer surrounded in the focal ring.
[Claim 3] The etching technique characterized by cooling the front face of the aforementioned focal ring even to temperature lower than the front face of the aforementioned wafer in the etching technique of claim 2 publication.

[Translation done.]

* NOTICES *

TECHNICAL FIELD

[The technical field to which invention belongs] this invention relates to the etching system which comes to prepare a focal ring in the side periphery of the lower electrode which lays especially a ** wafer, and the etching technique using this etching system about the etching system and the etching technique which are used in the manufacturing process of a semiconductor device.

[Translation done.]

* NOTICES *

PRIOR ART

[Prior art] The important section block diagram of the etching system used by the manufacturing process of a semiconductor device was shown in drawing 4 . The etching system shown in this drawing is also having a reaction chamber 1, the up electrode 2 and the lower electrode 3 prepared in the status countering mutually, in this reaction chamber 1, and the focal ring 4 which uses wafer installation side 3a in the lower electrode 3 as a base, and was prepared in the side periphery.
[0003] In etching the front face of a wafer using this etching system, first, wafer W is laid on wafer installation side 3a of the lower electrode 3, and it surrounds the side periphery of wafer W in a focal ring. Then, where process gas is introduced in a reaction chamber 1, a RF is impressed to the up electrode 2, by this, plasma P of process gas is generated in a reaction chamber 1, and plasma P is supplied to a wafer W front face. And the front face of the concerned wafer W is etched by this plasma P. In this case, plasma P is equally supplied to the wafer W front face laid on the lower electrode 3 by the focal ring 4 being formed in the status surround the side periphery of wafer W, and the homogeneity within a wafer side in etching is acquired.

[Translation done.]

* NOTICES *

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

EFFECT OF THE INVENTION

[Effect of the invention] Since etching of the wafer laid on the lower electrode where the front face of a focal ring is cooled can be performed according to the etching system of this invention as explained above, in case it is etching, it can prevent that a focal ring is heated, and a surface sediment separates and falls on a wafer. Therefore, it enables the precision of a configuration to perform good etching. Moreover, according to the etching technique of this invention, it is enabled to perform etching, without making the sediment of a resultant in the front face of a focal ring exfoliate from the concerned focal ring by performing etching, cooling the front face of a focal ring. Therefore, fall of the sediment to a wafer top can be prevented and it is enabled to perform etching with a good precision of a configuration.

[Translation done.]

* NOTICES *

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TECHNICAL PROBLEM

[Object of the Invention] However, the following technical probrems occur in the above-mentioned etching system and etching using this. That is, as shown in drawing 4 , since the focal ring was prepared in the side periphery of the lower electrode 3, the resultant by etching adheres to the front face of this focal ring 4, and sediment a by the above-mentioned resultant comes to be constituted from an etching system of the above-mentioned configuration by the front face of the focal ring 4 by piling up the processing number of sheets of wafer W. However, in the case of etching, the skin temperature of the focal ring 4 rises by the direct heat received from plasma P, and the radiant heat from the up electrode 2 and reaction chamber 1 side attachment wall. For this reason, the above-mentioned sediment a becomes easy to separate from the front face of the focal ring 4, and sediment a may fall on the front face of wafer W in the middle of etching. In such a case, this sediment a becomes the mask of etching and the etching remainder arises on the front face of wafer W.
[0005] progress of the micro-processing technique accompanied by a demand of high integration of recent years and a semiconductor device and highly-efficient-izing -- detailed-izing of the path of through holes, such as a dimension of a wiring, and a contact hole, -- progressing -- the inside of the above-mentioned through hole -- a tungsten -- like -- more -- low -- the plug using the conductive material [****] has come to form And after forming the tungsten layer 14 through the adhesion layer 13 first in the status embed the inside of the through hole 12 formed in the layer insulation layer 11 as shown in drawing 5 (1) in forming this plug using the above-mentioned etching system, etchback of the adhesion layer 13 and the tungsten layer 14 is carried out using the above-mentioned etching system. And as shown in drawing 5 (2), only in a through hole 12, it leaves the tungsten layer 14 and this is formed as plug 14a.
[0006] However, this sediment becomes the mask of etching when sediment a separated and falls to the front face of wafer W in the middle of the etchback of the tungsten layer which was with the above-mentioned etching system as mentioned above. Consequently, the etching remaining b of a tungsten layer arises on the layer insulation layer 11 after an etchback end. And when the upper wiring (illustration ellipsis) is formed on the layer insulation layer 11 at a next process, the etching remaining b will remain between this upper wiring. This etching remaining b makes between the upper wirings short-circuit, and becomes the factor which reduces the yield of a semiconductor device. This is the same even when the sediment a itself remains on the layer insulation layer 11, and it becomes the factor in which this sediment a makes between the above-mentioned upper wirings short-circuit.
[0007] Moreover, even if it was except formation of the above-mentioned plug, when the above-mentioned sediment a drops out on a wafer in etching at the time of carrying out patterning of the wiring, for example, this sediment a becomes the factor which makes between wirings short-circuit.
[0008] Then, this invention aims at offering the etching system and the etching technique of preventing that the sediment of the resultant by etching separates in the shape of a wafer, and falls from a focal ring.

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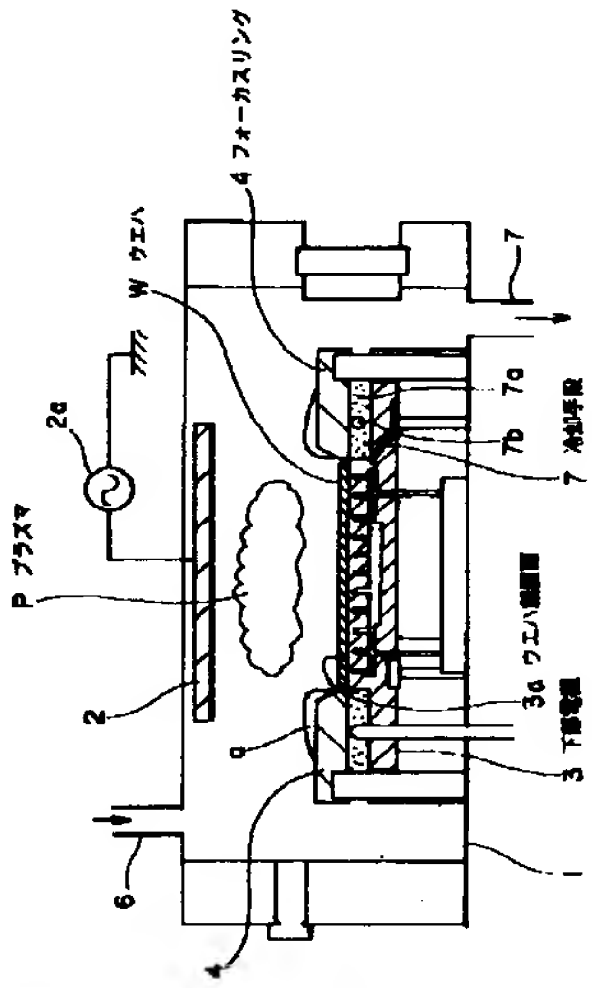
(54)【発明の名称】　エッチング装置及びエッチング方法

(57)【要約】
【課題】　フォーカスリング表面の堆積物がエッチング途中でウエハ上に剥がれ落ち、エッチングの形状精度を得ることができない。
【解決手段】　下部電極３のウエハ載置面３ａを底面にして、下部電極３の側周にフォーカスリング４を設けてなるエッチング装置において、フォーカスリング４の底面に冷却手段７を設けた。冷却手段７は、フォーカスリング４の底面に沿って密着配置された基材７ａ内に、フォーカスリング４の底面に沿って冷媒を循環させる冷媒管７ｂを内設してなるものである。これによって、フォーカスリング４の表面を冷却しながらエッチングを行うことが可能になり、フォーカスリング４表面の加熱によるフォーカスリング４表面からの堆積物ａの剥離が防止される。



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【特許請求の範囲】
【請求項１】　下部電極のウエハ載置面を底面にして、当該下部電極の側周にフォーカスリングを設けてなるエッチング装置において、
前記フォーカスリングには、当該フォーカスリングの表面を冷却する冷却手段を設けたことを特徴とするエッチング装置。
【請求項２】　側周がフォーカスリングで囲まれたウエハの表面にプラズマを供給することによって、当該ウエハの表面をエッチングする方法において、
前記フォーカスリングの表面を冷却することを特徴とするエッチング方法。
【請求項３】　請求項２記載のエッチング方法において、
前記フォーカスリングの表面を前記ウエハの表面よりも低い温度にまで冷却することを特徴とするエッチング方法。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、半導体装置の製造工程において用いられるエッチング装置及びエッチング方法に関し、特にはウエハを載置する下部電極の側周にフォーカスリングを設けてなるエッチング装置及びこのエッチング装置を用いたエッチング方法に関する。
【０００２】
【従来の技術】図４には、半導体装置の製造工程で用いられているエッチング装置の要部構成図を示した。この図に示すエッチング装置は、反応室１と、この反応室１内に互いに対向する状態で設けられた上部電極２及び下部電極３と、下部電極３におけるウエハ載置面３ａを底面としてその側周に設けられたフォーカスリング４とを有するのもである。
【０００３】このエッチング装置を用いてウエハの表面をエッチングする場合には、先ず、下部電極３のウエハ載置面３ａ上にウエハＷを載置し、ウエハＷの側周をフォーカスリングで囲む。その後、反応室１内にプロセスガスを導入した状態で上部電極２に高周波を印加し、これによって反応室１内にプロセスガスのプラズマＰを発生させ、プラズマＰをウエハＷ表面に供給する。そして、このプラズマＰによって当該ウエハＷの表面をエッチングする。この際、ウエハＷの側周を囲む状態でフォーカスリング４が設けられていることで、下部電極３上に載置したウエハＷ表面にプラズマＰが均等に供給され、エッチングにおけるウエハ面内均一性が得られる。
【０００４】
【発明が解決しようとする課題】しかし、上記エッチング装置及びこれを用いたエッチングにおいては、以下のような課題がある。すなわち、図４に示したように、上記構成のエッチング装置では、下部電極３の側周にフォーカスリングを設けたことから、エッチングによる反応

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生成物がこのフォーカスリング４の表面に付着し、ウエハＷの処理枚数を重ねることによってフォーカスリング４の表面に上記反応生成物による堆積物ａが構成されるようになる。ところが、エッチングの際には、プラズマＰから受ける直接的な熱や、上部電極２及び反応室１側壁からの輻射熱によって、フォーカスリング４の表面温度が上昇する。このため、上記堆積物ａがフォーカスリング４の表面から剥がれ易くなり、エッチング途中に堆積物ａがウエハＷの表面に落下する場合がある。このような場合には、この堆積物ａがエッチングのマスクになり、ウエハＷの表面にエッチング残りが生じる。
【０００５】近年、半導体装置の高集積化及び高機能化の要求に伴う微細加工技術の進歩によって、配線の寸法及び、コンタクトホール等のスルーホールの径の微細化が進み、上記スルーホール内にはタングステンのようにより低抵抗な導電性材料を用いたプラグが形成されるようになってきている。そして、上記エッチング装置を用いてこのプラグを形成する場合には、先ず、図５（１）に示すように、層間絶縁膜１１に形成したスルーホール１２内を埋め込む状態で密着層１３を介してタングステン膜１４を形成した後、上記エッチング装置を用いて密着層１３及びタングステン膜１４をエッチバックしている。そして、図５（２）に示すように、スルーホール１２内のみにタングステン膜１４を残し、これをプラグ１４ａとして形成している。
【０００６】ところが、上述のようにして、上記エッチング装置をもちいたタングステン膜のエッチバック途中でウエハＷの表面に堆積物ａが剥がれ落ちた場合には、この堆積物がエッチングのマスクになる。この結果、エッチバック終了後に層間絶縁膜１１上にタングステン膜のエッチング残りｂが生じる。そして、後の工程で層間絶縁膜１１上に上層配線（図示省略）を形成した場合に、この上層配線間にエッチング残りｂが残存することになる。このエッチング残りｂは、上層配線間をショートさせ、半導体装置の歩留りを低下させる要因になる。これは、堆積物ａ自体が層間絶縁膜１１上に残った場合でも同様であり、この堆積物ａが上記上層配線間をショートさせる要因になる。
【０００７】また、上記プラグの形成以外であっても、例えば配線をパターニングする際のエッチングにおいて上記堆積物ａがウエハ上に脱落した場合には、この堆積物ａが配線間をショートさせる要因になる。
【０００８】そこで本発明は、エッチングによる反応生成物の堆積物がフォーカスリングからウエハ状に剥がれ落ちることを防止できるエッチング装置及びエッチング方法を提供することを目的とする。
【０００９】
【課題を解決するための手段】上記課題を解決するための本発明のエッチング装置は、下部電極のウエハ載置面を底面にして、当該下部電極の側周にフォーカスリング

を設けてなるエッチング装置において、前記フォーカスリングには、当該フォーカスリングの表面を冷却する冷却手段を設けたことを特徴としている。

【００１０】上記エッチング装置によれば、フォーカスリングに設けた冷却手段によって、フォーカスリングの表面が冷却される。このため、エッチングの際にフォーカスリングの周囲で発熱が生じても、フォーカスリングの表面を冷却した状態で、下部電極上に載置したウエハのエッチングが行われる。したがって、エッチングの際に、フォーカスリングの表面における反応生成物の堆積物が、当該フォーカスリングから剥離し難くなる。

【００１１】また、本発明のエッチング方法は、側周がフォーカスリングで囲まれたウエハの表面にプラズマを供給することによって当該ウエハの表面をエッチングする方法において、前記フォーカスリングの表面を冷却することを特徴としている。

【００１２】上記エッチング方法によれば、フォーカスリングの表面が冷却された状態でエッチングが行われる。このため、エッチングの際には、フォーカスリングの表面における反応生成物の堆積物が、当該フォーカスリングから剥離し難くなる。したがって、フォーカスリング表面の堆積物をウエハ上に落下させることなくエッチングが行われる。

【００１３】

【発明の実施の形態】以下、本発明のエッチング装置及びエッチング方法を適用した実施の形態を図面に基づいて説明する。図１は、本発明のエッチング装置の一実施形態を示す要部構成図であり、先ずこの図を用いてエッチング装置の実施の形態を説明する。尚、従来の技術で説明したと同様の構成要素には同一の符号を付して説明を行う。

【００１４】この図に示すエッチング装置は平行平板型のエッチング装置であり、反応室１と、この反応室１内に互いに対向する状態で設けられた上部電極２及び下部電極３と、下部電極３の側周に設けられたフォーカスリング４とを有するのもである。

【００１５】反応室１の上面には、当該反応室１内にプロセスガスを導入するためのガス導入管６が接続されている。また、反応室１の下面には、反応室１内のガスを排気するための排気管７が接続されている。そして、反応室１は、ここでは図示を省略したロードロック室に接続されており、このロードロック室から反応室１内には真空状態を確保したままでウエハWが収納されるようになっている。また、上記ロードロック室には、この反応室１以外にもその他の複数の反応室やウエハを待機させておくカッセット室が接続されていても良く、全体としてマルチチャンバとして構成されているものであっても良い。

【００１６】そして、上記上部電極２は、反応室１の上方に設けられており、プラズマ励起源となる高周波電源２ａに接続されている。さらに、上記下部電極３は、上部電極２と対向する状態で反応室１内に設けられており、例えば冷媒導入路が内設された静電チャックとして構成されている。

【００１７】また、上記フォーカスリング４は、下部電極３におけるウエハ載置３ａを底面としてその側周壁を構成する状態で、当該下部電極３の上部側周に設けられている。そして、このこのフォーカスリング４の底面に、本発明に特徴的な構成要素である冷却手段７が設けられている。この冷却手段７は、フォーカスリング４の下面に沿って設けられたものであり、フォーカスリング４の下面に密着させて設けられた熱伝導性の良好な材料からなる基材７ａ内に、フォーカスリング４の底面に沿って冷媒を循環させる冷媒管７ｂを内設してなるものである。この冷媒管７ｂは、下部電極３の冷媒導入路とは個別に設けられたものである。また、冷却手段７には、フォーカスリング４の表面温度を制御するための温度制御機能（図示省略）が備えられており、上部電極２、下部電極３及び反応室１等とは別に、フォーカスリング４の表面温度を独立して制御可能に構成されていることとする。

【００１８】上記構成のエッチング装置では、排気管７からの排気によって反応室１内を所定の減圧状態にし、ガス導入管６からプロセスガスを導入して上部電極２に高周波電源２ａから高周波を印加することで、反応室１内でプロセスガスのプラズマが発生する。この際、下部電極３の側周に設けられたフォーカスリング４によって、下部電極３上に載置したウエハWにプラズマが均等に供給され、このプラズマによってウエハWの表面がエッチングされる。そして特に、フォーカスリング４の下面に設けた冷却手段７によって、フォーカスリング４の表面が冷却されるため、エッチングの際にプラズマPから受ける直接的な熱や、上部電極２及び反応室１側壁からの輻射熱によって、フォーカスリング４の表面温度が上昇することが抑えられる。このため、エッチングによる反応生成物がフォーカスリング４表面に堆積して堆積物ａが形成されていても、この堆積物ａがフォーカスリング４表面から剥がれ難くなる。したがって、エッチングの際に、この堆積物ａがウエハW上に落下することはない。

【００１９】図２は、本発明のエッチング方法をタングステンからなるプラグの形成方法に適用した実施の形態を説明するための断面工程図である。以下にこの図２と共に上記図１を用いて、上記エッチング装置を用いたタングステンからなるプラグの形成方法を説明する。

【００２０】先ず、図２（１）に示すように、基板２１の上部にポリシリコンからなる下層配線２２を形成する。この下層配線２２の形成は、ＣＶＤ(Chemical Vapor Depositin)法によって形成したポリシリコン膜をパターニングすることによって行う。次に、下層配線２２を

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覆う状態で、基板２１上に層間絶縁膜１１を形成する。この層間絶縁膜１１は、例えばＣＶＤ法によって形成したＢＰＳＧ膜またはＰＳＧ膜で構成されることとする。その後、層間絶縁膜１１をパターニングすることによって、この層間絶縁膜１１に下層配線２２に達するスルーホール１２を形成する。

【００２１】次いで、図２（２）に示すように、スルーホール１２の内壁を覆う状態で、層間絶縁膜１１上にチタンからなる密着層１３をスパッタ法にて形成する。その後、スルーホール１２の深さを越える膜厚で、密着層１３上にタングステン膜（以下、タングステン膜と記す）１４を形成する。これによって、スルーホール１２内をタングステン膜１４で完全に埋め込む。

【００２２】以上の後、図２（３）に示すように、スルーホール１２の内部にのみタングステン膜１４及び密着層１３を残すように、タングステン膜１４及び密着層１３をその表面側からエッチバックし、層間絶縁膜１１上のタングステン膜１４及び密着層１３を除去する。

【００２３】この際、上記図１を用いて説明したエッチング装置を用い、下部電極３の載置面３ａ上に基板２１＊（すなわちウエハＷ）を載置し、排気管７からの排気によって反応室１内を所定の圧力にまで減圧した後、ガス導入管６からプロセスガスを所定の流量で導入した状態で上部電極２に高周波電源２ａから高周波電圧を印加する。これによって、反応室１内にプロセスガスのプラズマＰを発生させて、フォーカスリング４で囲まれたウエハＷの表面にこのプラズマＰを供給し、これによってウエハＷをその表面側からエッチングする。

【００２４】この際特に、エッチング装置の冷却手段７における冷媒管７ｂに冷媒を循環させることによって、フォーカスリング４の表面を冷却することが、本実施形態の特徴となる。フォーカスリング４の冷却条件としては、好ましくはウエハＷの表面温度よりも低い温度とする。冷却条件の一例としては、上部電極２の温度＝７０℃、下部電極３の温度＝２５℃、反応室１側壁の温度＝４５℃に制御した場合に、フォーカスリング４の冷却温度＝２０℃程度に設定する。

【００２５】上記温度条件下におけるタングステン膜１４及び密着層１３のエッチング条件の一例を以下に示す。

・タングステン膜１４の初期エッチング条件（第１ステップ）、
　プロセスガス及び流量　　；６フッ化硫黄（SF_6）＝１１０sccm、
　　アルゴン（Ａｒ）　＝　９０sccm、
　エッチング雰囲気内圧力　；３７．３Ｐａ、
　高周波（13.56MHz）印加電力；６００Ｗ、
　エッチング時間　　；３５秒。
・タングステン膜１４のエッチング条件（第２ステップ）、
　プロセスガス及び流量　　；６フッ化硫黄（SF_6）＝　８０sccm、
　　アルゴン（Ａｒ）　＝　４０sccm、
　エッチング雰囲気内圧力　；２８．０Ｐａ、
　高周波（13.56MHz）印加電力；３００Ｗ、
　エッチング時間　　；終点検出まで。
・タングステン膜１４のオーバーエッチング条件（第３ステップ）、
　プロセスガス及び流量　　；６フッ化硫黄（SF_6）＝　８０sccm、
　　アルゴン（Ａｒ）　＝　４０sccm、
　エッチング雰囲気内圧力　；２８．０Ｐａ、
　高周波（13.56MHz）印加電力；３００Ｗ、
　エッチング時間　　；４５秒。
・密着層１３のエッチング条件、
　プロセスガス及び流量　　；塩素（Cl_2）＝　２０sccm、
　　窒素（N_2）　＝２００sccm、
　エッチング雰囲気内圧力　；　５．３Ｐａ、
　高周波（13.56MHz）印加電力；５５０Ｗ、
　エッチング時間　　；７５秒。

ただし、上記sccmは、standard cubic centimeter/minutes であることとする。

【００２６】以上のようにして、スルーホール１２内にのみ密着層１３及びタングステン膜１４を残すことによって、このスルーホール１２内に密着層１３を介してタングステンからなるプラグ１４ａを形成する。

※【００２７】その後、図３に示すように、スパッタ法によって層間絶縁膜１１上にプラグ１４ａを覆う状態でアルミニウム膜１５を形成し、このアルミニウム膜１５をパターニングし、アルミニウムからなる上層配線１５ａを形成する。これによって、プラグ１４ａに接続された上層配線１５ａを層間絶縁膜１１上に形成してなる半導

体装置を完成させる。

【００２８】上記方法では、フォーカスリング４の表面を冷却した状態でタングステン膜１４のエッチバックが行われ、このエッチバックの際にはプラズマＰから受ける直接的な熱や、上部電極２及び反応室１側壁からの輻射熱によって、フォーカスリング４の表面温度が上昇することが抑えられる。このため、フォーカスリング４の表面における反応生成物の堆積物ａを当該フォーカスリング４から剥離し難くすることが可能になる。したがって、上記エッチバックの際にウエハＷ上に堆積物ａが剥がれ落ちることはなく、層間絶縁膜１１上にこの堆積物ａが残ったり、この堆積物ａをマスクにしたエッチング残りを生じることが防止される。この結果、層間絶縁膜１１上に形成した上層配線１５ａ間が堆積物ａや上記エッチング残りによってショートすることが防止され、半導体装置の歩留りの向上を図ることが可能になる。

【００２９】上記実施形態においては、フォーカスリング４の下面に冷却手段７を設けた構成のエッチング装置を例示した。しかし、冷却手段７としては、フォーカスリング４に冷媒管を内設した構成であっても良い。また、本発明のエッチング装置は、下部電極３のウエハ載置面３ａを底面としてその側周にフォーカスリング４を有するエッチング装置４であれば、本実施形態で説明した平行平板型のものに限定されることはなく、例えばマグネトロン、ＥＣＲ、誘導放電またはヘリコン波をプラズマ源とするその他のエッチング装置に適用可能であり、同様の効果を得ることができる。

【００３０】また、上記実施形態においては、タングステンプラグの形成におけるタングステン膜のエッチバックに上記エッチング装置を用いた場合のエッチング方法を説明した。しかし、本発明のエッチング方法は、これに限定されるものではなく、配線形成やスルーホール形成のためのパターニング等におけるその他エッチングにも適用され、同様の効果を得ることが可能である。

【００３１】

【発明の効果】以上説明したように本発明のエッチング装置によれば、フォーカスリングの表面を冷却した状態で下部電極上に載置したウエハのエッチングを行うことができるため、エッチングの際にフォーカスリングが加熱されて表面の堆積物がウエハ上に剥がれ落ちることを防止できる。したがって、形状の精度が良好なエッチングを行うことが可能になる。また、本発明のエッチング方法によれば、フォーカスリングの表面を冷却しながらエッチングを行うことで、フォーカスリングの表面における反応生成物の堆積物を当該フォーカスリングから剥離させずにエッチングを行うことが可能になる。したがって、ウエハ上への堆積物の落下を防止でき、形状の精度の良好なエッチングを行うことが可能になる。

【図面の簡単な説明】

【図１】本発明のエッチング装置の一実施形態を示す要部構成図である。

【図２】本発明のエッチング方法をタングステンからなるプラグの形成方法に適用した実施形態を説明するための断面工程図である。

【図３】本発明のエッチング方法を適用して形成された半導体装置の断面図である。

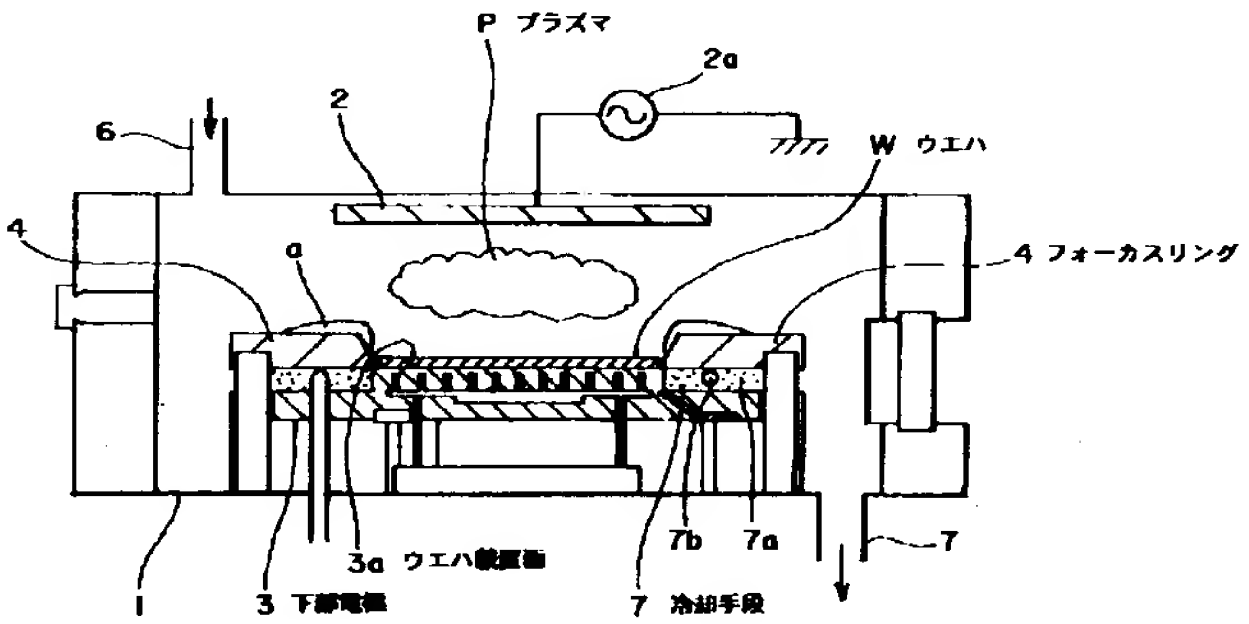
【図４】従来のエッチング装置の一例を示す要部構成図である。

【図５】従来の課題を説明するための断面図である。

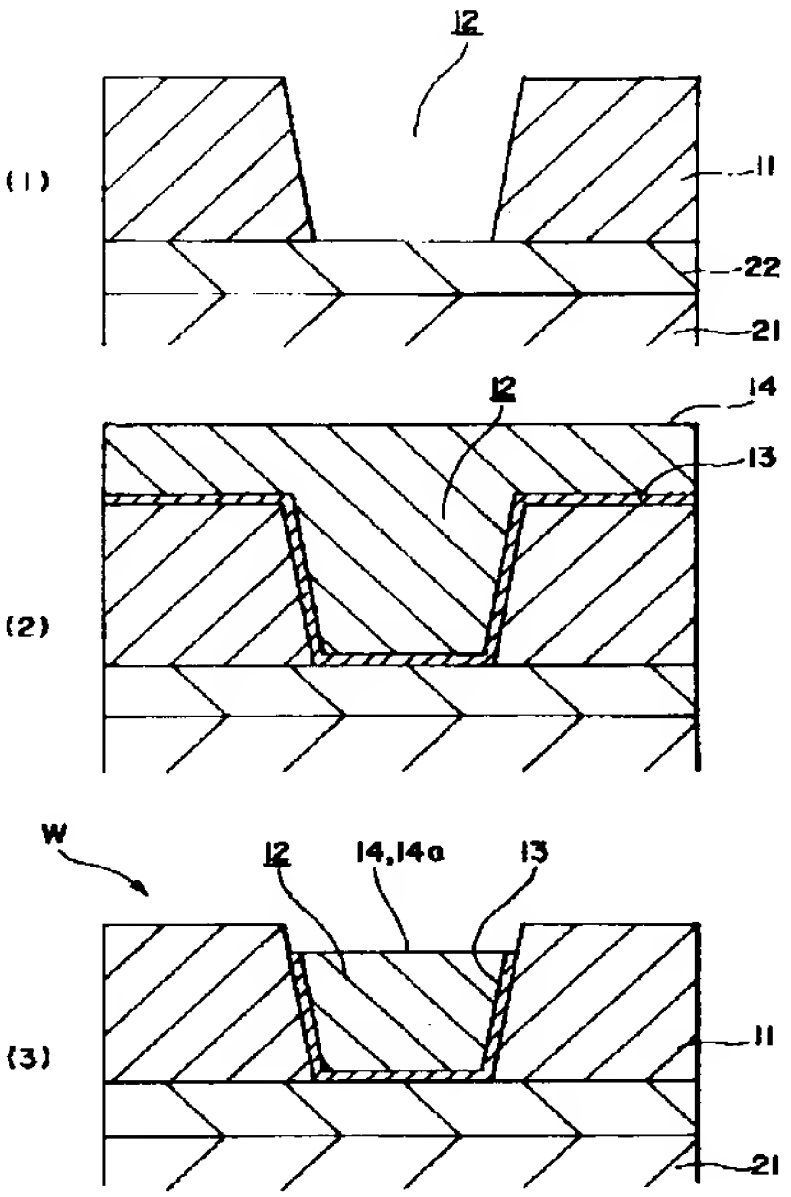
【符号の説明】

３…下部電極、３ａ…ウエハ載置面、４…フォーカスリング、７…冷却手段、Ｐ…プラズマ、Ｗ…ウエハ

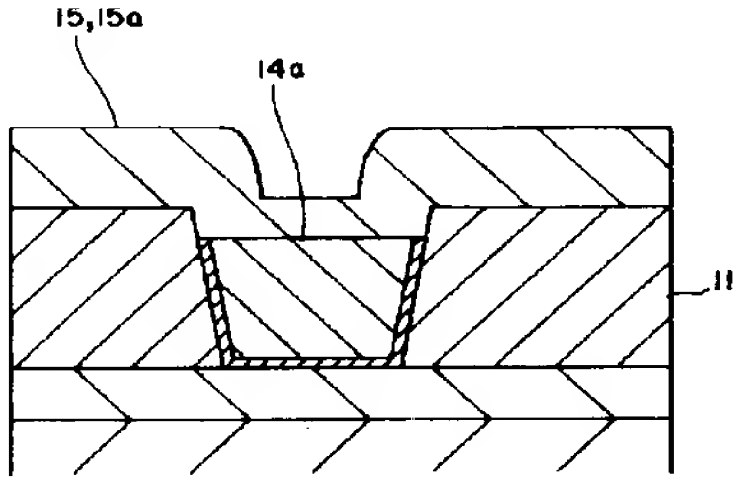
【図１】



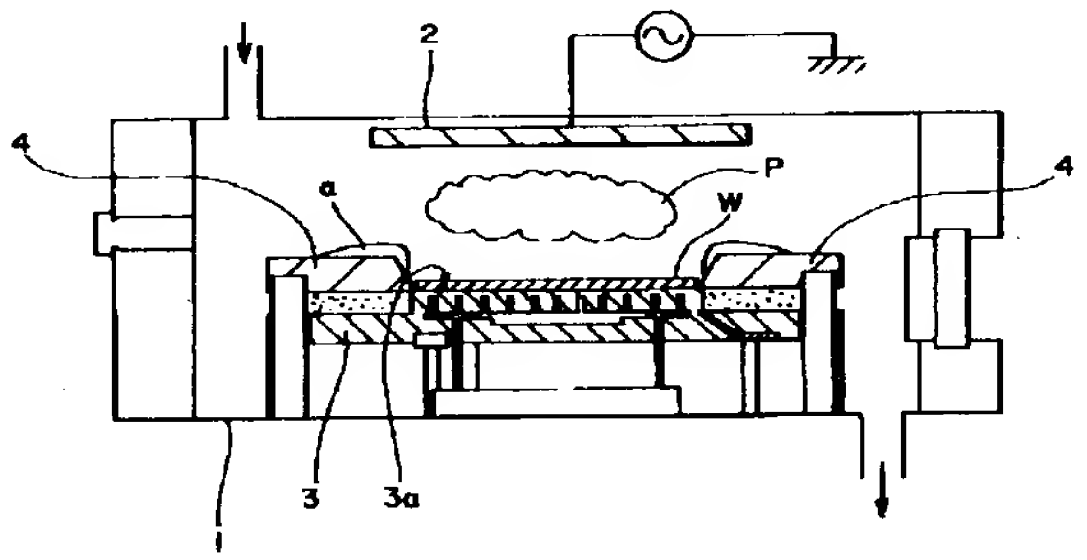
【図2】


(1)
12
11
22
21
(2)
12
14
13
(3)
W
12
14,14a
13
11
21

【図3】


15,15a
14a
11

【図4】


2
4
a
P
W
4
3
3a
1

【図5】